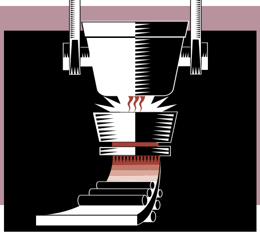
Technology Success Story

STEEL



Hot Blast Stove Process Model and Model-Based Controller

Benefits

- Optimizes stove thermal performance and operational consistency
- Improves stove system reliability through increased conformance to stove system design-based operational constraints
- Reduces natural gas consumption for hot blast stove use by six-to-seven percent (less than $1,000 per day) while delivering hot blast gas at a specified temperature and rate
- Allows operators to spend more time on furnace control and less on stove control thereby improving blast furnace performance
- Can be customized into a site-specific stove design, enabling accurate modeling regardless of hot blast stove configuration

"This is an excellent example of how industry/government partnerships should work. Pinakin Chaubal and his team at ISPAT Inland were enthusiastic and cooperative throughout the project."

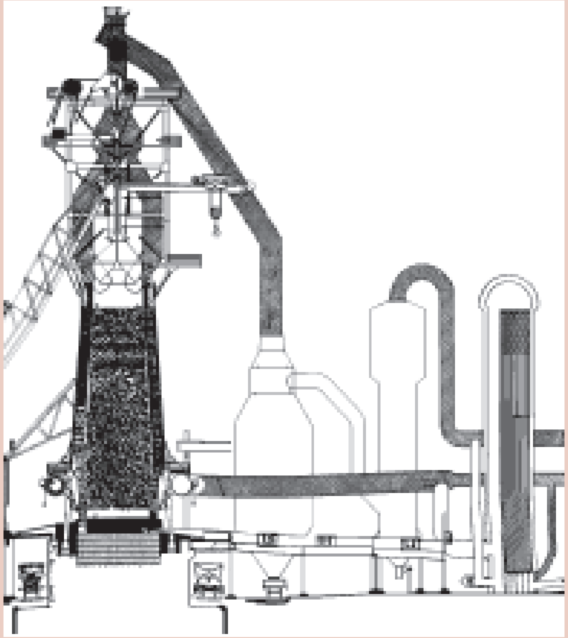
--- Dominic Cagliostro, Project Leader, Los Alamos National Laboratory

Model provides closer process control and enhanced product quality

The steel industry annually produces approximately 50 million tons of molten (or "pig") iron valued at over eight billion dollars, in tall, shaft-type furnaces known as blast furnaces. Hot blast air, typically augmented with natural gas or coal, is injected into the base of the blast furnace to combust with coke, a coal-based reductant used in ironmaking. A single blast furnace has three or four hot blast stoves whose purpose is to preheat the blast air prior to its delivery to the furnace. These stoves are usually heated by the combustion of blast furnace gas, supplemented with natural gas. Preheating the blast furnace air increases ironmaking energy efficiency and hot metal production rates.

Consistent delivery of preheated blast air to the furnace within a specified temperature range is key to controlling the thermal state of the blast furnace. Achieving this reliable delivery with minimal fuel consumption in the stove would be a significant achievement for the industry. The reactions occurring in the stove are thermodynamically complex and can only be analyzed using a fairly sophisticated heat transfer model. Such a model would enable steel mill operators and laboratory personnel to gather accurate thermodynamic data from the hot blast stove and use them to optimize the stove's heat transfer characteristics.

Blast Furnace



Cross-section of a typical blast furnace.

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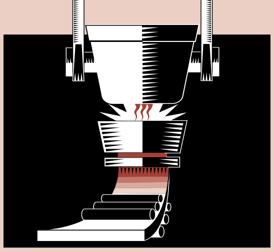
Solution

In collaboration with the Los Alamos National Laboratory (LANL) and ISPAT Inland, Inc., the Department of Energy's Office of Industrial Technologies (OIT) developed, tested, and subsequently validated a hot blast stove heat transfer model for commercial use in a steel mill. The model is used as part of a predictive control scheme to determine the minimum quantity of fuel required to achieve a specified hot blast temperature at a given flow rate.

The hot blast stove process model can be incorporated into a variety of blast stove designs. Prior to its full-scale commercialization at any one location, the process model and its control system is configured to site-specific stove system designs. LANL's technical staff can help steel companies with this process.

Results

Following the project's inception in November, 1996, the first hot blast stove process model and control system achieved commercialization in the latter part of 1998. The first model was used on one stove in the ISPAT Inland, Inc. No. 7 blast furnace. Due to its immediate success in one blast stove of ISPAT's No. 7 blast furnace, the model was soon implemented in all three of its stoves. Comparisons of stove operation both with and without the model based controller by technical personnel from ISPAT and LANL documented six-to-seven percent reductions in natural gas use with the controller. At the time, this was equivalent to approximately $1,000 day in energy cost savings; with today's higher gas prices, the savings would be even greater. Not only has the model improved the blast furnace's operating performance, but also has increased its reliability. The model is still in use at the Indiana Plant of ISPAT Inland, Inc.



For additional information, contact:

Dominic J. Cagliostro
Los Alamos National Laboratory
MS-F645
P.O. Box 1663
Los Alamos, NM 87545
Phone: (505) 667-8500
Fax: (505) 667-3389
DJC@lanl.gov

For program information, contact:

Gobind Jagtiani
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585-0121
Phone: (202) 586-1826
Fax: (202) 586-3237
gobind.jagtiani@ee.doe.gov

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Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585

OIT

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